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**Engineering And Design  
ENVIRONMENTAL ENGINEERING INITIATIVES FOR WATER  
MANAGEMENT**

**1. Purpose**

This engineer technical letter (ETL) provides guidance for implementing the U.S. Army Corps of Engineers' policy to meet the environmental engineering initiatives of the Chief of Engineers and identifies areas of concern and opportunity related to the physical, chemical, and biological integrity of inland and coastal project waters. While a number of techniques are listed in this ETL, other innovative approaches for environmental improvement through water management are encouraged.

**2. Applicability**

This ETL is applicable to all HQUSACE elements, major subordinate commands, districts, laboratories, and field operating activities involved in water management activities at civil works projects.


FOR THE DIRECTOR OF CIVIL WORKS:

APP A - Environmental Engineering Initiatives  
for Water Management

**3. Discussion**

*a.* This ETL provides an outline of technical issues that need to be addressed in carrying out environmental initiatives. The examples presented are not to be considered as being a complete list of all possible issues, but should be used as a basis for developing applications to specific water management challenges.

*b.* Interagency coordination and consideration of local user requirements are an essential component for decision making. Details and information for implementing programs to address these issues are available from the Chief of Engineers' Committee on Water Quality (CECW-EH-W at (202) 761-8512).

  
**DOUGLAS J. KAMIEN**  
Acting Chief, Engineering Division  
Directorate of Civil Works

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## APPENDIX A: ENVIRONMENTAL ENGINEERING INITIATIVES FOR WATER MANAGEMENT

### A-1. Introduction

The U.S. Army Corps of Engineers (Corps) manages about 780 inland water resources projects across the continental United States. Authorized purposes include flood control, navigation, hydropower generation, irrigation, water supply, fish and wildlife habitat, environmental restoration and protection, recreation, and water quality. Even where not specifically addressed in the Corps' authorizing documents, Public Laws, Executive Orders, and other regulations charge field offices with responsibility for sound environmental management at all Corps of Engineers projects.

### A-2. Authority

A brief list of legislative actions and engineering guidance that establish the authority for much of the activity presented in this ETL is presented below.

#### *a. Legislation.*

(1) The Corps' water quality management authority is founded on the Federal Water Pollution Control Act of 1948 and its amendments up to and including the Clean Water Act of 1977 (Public Law 95-217, 33 U.S.C. 1251 et seq.) and the Water Quality Act of 1987. Executive Order 12088, Federal Compliance With Pollution Control Standards, dated October 13, 1978, requires compliance by Federal facilities and activities with applicable pollution control standards in the same manner as any non-Federal entity.

(2) Section 102 of Public Law 92-500, Federal Water Pollution Control Act (Clean Water Act) of 1972, and the amendments of 1977 (Public Law 95-217, 33 U.S.C. 1251 et seq.) form the basis for reservoir related water quality responsibilities in the Corps.

(3) Section 401 of Public Law 92-500, Federal Water Pollution Control Act (Clean Water Act) of 1972, is the basis for state water quality certification for discharging into navigable waterways.

(4) Section 404(a) of Public Law 92-500, Federal Water Pollution Control Act (Clean Water Act, 33 U.S.C. 1251) of 1972, applies to dredged material disposal.

(5) Section 404(b)(1) of Public Law 92-500, Federal Water Pollution Control Act (Clean Water Act, 33 U.S.C. 1344) of 1972, is the basis for the permit system for discharging dredged or fill material into the waters of the United States administered by the U.S. Army Corps of Engineers.

(6) Section 103 of Public Law 92-532, Marine Protection, Research and Sanctuaries Act, requires permits for ocean disposal of dredged material and requires that disposal will not unreasonably degrade or endanger human health and welfare or the marine environment.

(7) The Defense Environmental Restoration Program on Formally Used Defense Sites is authorized by the Defense Appropriation Act (Public Law 98-212).

(8) Section 1135 of Public Law 99-662, Water Resources Development Act of 1986, allows the Corps to modify its water resources projects in partnership with a non-Federal sponsor to improve the quality of the environment.

(9) Section 306 of Public Law 101-640, Water Resources Development Act of 1990, states that environmental protection is now "one of the primary missions of the Corps of Engineers in planning, designing, constructing, operating, and maintaining water resources projects." Section 306 strongly reinforces the goals of the Corps' Environmental Program.

(10) Section 307 of Public Law 101-640, Water Resources Development Act of 1990 (WRDA 90), states that, "as part of the Corps of Engineers water resources development program, an interim goal of no overall net loss of the Nation's remaining wetlands base, as defined by acreage and function, and a long term goal to increase the quality and quantity of the Nation's wetlands," the Corps "shall utilize all

appropriate authorities, including those to restore and create wetlands, in meeting the interim and long-term goals." Executive Order 11990 further requires that the Corps avoid undertaking or assisting in the construction in wetlands unless there is no practicable alternative.

(11) Federal Facilities Compliance Act of 1992, which provides for EPA and/or states to undertake thorough inspections of Federally owned or operated facilities that are subject to the CWA to ensure compliance.

(12) Section 310(b) of WRDA 90 requires public participation in the development of or changes in water control plans.

*b. References.*

(1) ER 15-2-14, Committees on Tidal Hydraulics, Channel Stabilization, Water Quality, and Hydrology.

(2) ER 1105-2-100, Guidance for Conducting Civil Works Planning Studies.

(3) ER 1110-1-261, Quality Assurance of Laboratory Testing Procedures.

(4) ER 1110-1-263, Chemical Data Quality Management for Hazardous Waste Remedial Activities.

(5) ER 1110-1-8100, Laboratory Investigations and Materials Testing.

(6) ER 1110-2-240, Water Control Management.

(7) ER 1110-2-1150, Engineering and Design for Civil Works Projects.

(8) ER 1110-2-1462, Water Quality and Water Control Considerations for Non-Federal Hydropower Development at Corps of Engineers Projects.

(9) ER 1130-2-334, Reporting of Water Quality Management Activities at Corps Civil Works Projects.

(10) ER 1165-2-27, Establishment of Wetlands Areas in Connection with Dredging.

(11) EM 1110-2-1201, Reservoir Water Quality Analyses.

### **A-3. Background**

The Corps' water quality program established in the early 1970's was one of the first steps taken by the Corps to include environmental factors in the planning, design, construction, and operation of its water resources projects. Important program components addressing other environmental factors including expanded fisheries programs and suitability of habitat and biological diversity programs were accelerated after the water quality program. The discipline of water quality in the Corps of Engineers encompasses the physical, chemical, and biological integrity of project-associated resources. These three broad components (physical, chemical, and biological) of water quality are interrelated and in combination describe and determine the water and related environments of the projects.

### **A-4. Policy**

a. It is national policy that the Federal government, in the design, construction, management, operation, and maintenance of its facilities, shall provide leadership in the nationwide effort to protect and enhance the quality of the air, water, and land resources and to comply with all Federal, state, interstate, and local requirements to the same manner and extent as other entities. Federal antidegradation policy maintains and protects existing high quality waters where they constitute an outstanding national resource. Where the quality of a water resource supports a diverse, productive, and ecologically sound habitat, those waters will be maintained and protected unless there is compelling evidence that to do so will cause significant national economic and social harm. No degradation is allowed without substantial proof that the integrity of the stream will not diminish. In all cases, the existing instream water uses and the water quality necessary to protect them will be maintained. This national policy is founded on the overall objective established in the Clean Water Act to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. The thrust of this policy is to protect all existing and future uses including assimilative capacity, aquatic life, water supply, recreation, industrial use, hydropower, etc. Where uses are degraded, it is the national goal to restore those degraded waters to more productive conditions.

b. The Corps' policy is to take a leadership role in carrying out the goals and objectives of the national policy by managing the Nation's water resources that are under the Corps' control so that they are protected, maintained, and restored. As steward of project resources, the Corps will not allow degradation of the aquatic resource except as noted above. In cases where degradation has occurred, it is Corps policy to restore, to the extent justified, the resource to a biologically productive, diverse, and ecologically robust condition. As appropriate this ecosystem restoration will be accomplished in cost sharing partnerships with non-Federal interests. Corps management responsibilities extend throughout the area influenced by and influencing the water managed. Because management of projects affects environments distant from the property boundaries and is influenced by actions of others also distant from the properties, the Corps must actively pursue a management philosophy committed to partnering with a wide range of resource organizations and interested individuals. It is Corps policy to develop and implement a holistic, environmentally sound water quality management strategy for each project. This strategy must be developed in concert with other authorized project purposes. However, the environmental aspects of all we do must have *equal* standing among other aspects--not simply a "consideration," but part of the "go-no-go" test along with economics and engineering. The Corps will manage its projects in accordance with all applicable Federal and state environmental laws, criteria, and standards. The four pillars of the Army's environmental strategy (conservation, prevention, restoration, and compliance) will help guide the Corps policy for water quality management.

#### **A-5. Environmental Engineering for Water Management**

a. The Corps must become and remain comprehensively aware of and responsive to conditions which impact the environment, not only at projects, but beyond project boundaries (i.e., tributary basin and downstream reaches influenced by project operations). Water management operations must be periodically reviewed to determine if water quality/environmental objectives are being achieved. The objectives themselves must be subject to periodic scrutiny to determine if they remain pertinent relative to changing environmental conditions and public

expectations for improved water quality. It is essential that a team approach using all available technical expertise be used in development and review of water quality and environmental objectives and goals.

b. Environmental initiatives are not limited to major structural and operational modifications to projects. Added flexibility in water management procedures may be required to balance designated uses with environmental needs. The Corps must draw upon its many technical strengths and resources (team approach) for environmentally sound management, operation, and maintenance of its projects. Available techniques and methodologies to improve environmental performance have not yet been applied or fully utilized at many Corps projects. In many cases relatively minor modifications to water management operations and/or water control structures can be made, within existing discretionary authority, that can produce significant environmental benefits at nominal or no cost with negligible impact on other project purposes. No management decision should be made without an environmental sensitivity check. Significant changes to environmental conditions may require appropriate documentation.

c. Environmental engineering initiatives must be an integral part of all phases of civil works planning, design, construction, operation, and maintenance. In keeping with the Army's environmental stewardship vision, this ETL provides guidance necessary to develop and implement applicable environmental engineering initiatives (pursuant to ER 1130-2-334). Examples of techniques that can improve the physical, chemical, and biological integrity of inland waters are presented.

#### **A-6. Environmental Engineering Opportunities**

a. It is not the intent of this ETL to describe in detail all the possible options that are available for environmental engineering improvement through the management of the water resources that are controlled or influenced by Corps projects. To do so would require extensive text that would be inappropriate to present in the form of an ETL. Much of what follows is in outline form and is presented to stimulate thought that may produce ideas that can be implemented at Corps projects. Included are general development and implementation guidance.

b. Environmental engineering initiatives have expanded the scope of water management participation in addressing Corps environmental issues. Environmental engineering, water quality, biological, and water control expertise are essential to address issues related to the following:

- (1) Aquatic habitat.
  - (a) Aquatic habitat studies.
  - (b) Aquatic habitat restoration.
  - (c) Fish habitat studies.
  - (d) Fish habitat restoration.
  - (e) Zebra mussel or other invasive/exotic species monitoring.
  - (f) Endangered species protection and restoration.
- (2) Long-term management strategies for the disposal of dredged material.
  - (3) Wetlands habitat.
    - (a) Monitoring of wetlands.
    - (b) Management of wetlands.
    - (c) Wetlands studies.
    - (d) Wetlands restoration.
    - (e) Wetlands creation.
  - (4) Upland habitat creation.
- (5) Hazardous, toxic, and radioactive wastes (HTRW).
  - (a) Onsite cleanups.
  - (b) Monitoring of HTRW.
  - (c) Cooperative agreements.
  - (d) Development of remediation plans.

(e) Interagency programs such as U.S. Environmental Protection Agency Superfund program support.

#### A-7. Examples of Environmental Initiatives

##### a. Structural modifications.

- (1) Outlet structures.
  - (a) Selective withdrawal to control downstream water quality and effect desired in-pool changes.
  - (b) Mixers and aerators to improve outflow water quality.
  - (c) Weirs, sills, and baffles to efficiently aerate and promote gas exchange.
  - (d) Turbine venting to improve downstream water quality.
  - (e) Design to eliminate gas supersaturation problems.
  - (f) Tailwater/outflow fishery habitat design (i.e., rocks, outflow embayments).
  - (g) Fish passage devices to provide passage over and around vertical obstructions.
  - (h) Use of Olzewski tubes for selective withdrawal.
  - (i) Work with contractors and retrofit developers to ensure that water quality and other project purposes are not adversely impacted.
- (2) In-pool structures.
  - (a) Mixers, diffusers, pumps, and aerators to destratify impoundments and aerate hypolimnetic waters.
  - (b) Shoreline stabilization and use of vegetation to control erosion.
  - (c) Subimpoundments.

(d) Wetlands on and off project lands (downstream).

(e) Sediment traps.

(f) Wetland/sediment traps.

(g) Debris traps.

(h) Skimming weirs and/or curtains at swimming beaches or other sensitive areas.

(i) Fish and wildlife structures (i.e., spawning shoals, reefs, islands).

(j) Silt curtain/turbidity control.

(3) River, stream, and coastal improvements.

(a) Design features to provide habitat and to maintain or improve water quality in new or rehabilitated local flood protection channels.

- Weirs, pools, and riffles.
- Single bank construction.
- Low flow channels.
- Entrenched meanders.
- Fish passages.
- Cover devices to provide shading to moderate thermal impacts.
- Water control structures (gated structures, inflatable dams, overflow weirs, earth plugs).
- Instream habitat structures (sills, deflectors, random rocks).

(b) Aerating structures at locks and dams.

(c) Habitat along or adjacent to navigation channels.

(d) Dikes to control saltwater intrusion.

(e) Beneficial use of dredged material to create fish and wildlife habitat.

(f) Beach erosion control.

(g) Beach nourishment.

(h) Groundwater recharge.

(4) Ecological improvements or ideas.

*b. Operational modifications.*

(1) Management of selective withdrawal systems.

(a) Meet downstream water temperature schedules and water quality objectives.

(b) Evacuate/store undesirable waters to balance long-term overall quality.

(c) Modify outflow quality objectives to balance long-term in-lake and outflow quality.

(d) Gradually change outflow quality by releasing waters from different levels when sudden outflow quality change is anticipated (flood control).

(e) Prioritize outflow quality objectives for balancing outflow quality.

(2) Seasonal pool elevation changes and temporary pool fluctuations.

(a) Increase spring pools or change reservoir filling schedules to flood spawning shoals during critical spawning periods.

(b) Provide winter drawdowns to flush accumulated silt from gravel spawning beds where necessary and appropriate.

(c) Limit pool fluctuation during spawning periods to avoid desiccation of fish eggs and fry.

(d) Provide winter drawdowns to promote cropping of overpopulated and stunted panfish when feasible and appropriate.

(e) Provide short-term detention of excess storage to meet low flow augmentation needs.

(f) Use pool fluctuations to induce in-pool mixing and to reestablish natural downstream flow variations.

(g) Change pool elevations to increase or decrease hydraulic retention time to change pool sedimentation patterns.

(h) Increase water storage to increase retention time/trap efficiency to allow settling of heavy metal degraded inflows and suspended solids to improve pool and outflow quality.

(i) Evacuate/store undesirable strata of water (i.e., anoxic, nutrient rich, acidity, or metal degraded waters).

(j) Use pool fluctuation to control mosquitoes or other nuisance organisms.

(k) Manage drought for flow enhancement.

(l) Use pool drawdown during the summer to promote growth of emergent/terrestrial vegetation to provide shoreline erosion protection or habitat.

(m) Use winter drawdown to desiccate nuisance plants.

(3) Discharge schedules and flow augmentation operations.

(a) Augment downstream flows to dilute, neutralize, cool, aerate, or otherwise improve target waters.

(b) Moderate rates of change to avoid thermal shocking of fish, fish stranding, scouring, and other disruptive impacts.

(c) Establish system operations for both Federal and non-Federal reservoirs to provide water quality/environmental benefits.

(d) Establish in-stream flow needs and appropriate minimum flow values.

(e) Use real-time operations based on variations in tributary flow and water quality conditions at downstream target reaches.

(f) Prevent fish entrainment, or conversely, use deliberate fish flushing operations to replenish downstream populations where desired and appropriate.

(g) Promote migration of anadromous fish.

(h) Schedule maintenance and inspection shutdowns at times of least environmental impact.

- Schedule cool season, high downstream uncontrolled flow periods to minimize biological and water quality impacts.
- Utilize pumping and/or bypass flows to sustain tailwater during shutdowns.
- Limit duration of shutdowns.
- Perform preshutdown and postshutdown compensation flow increases.
- Perform fish salvage and relocation operations.
- Encourage creative uses of excess flood waters (i.e., selenium flushing in degraded agricultural areas).
- Perform emergency operations to either slow or flush sewage, chemical, and oil spills from water intakes or other sensitive areas.
- Induce periodic controlled flooding of flood plain to maintain wetlands and similar type habitats.

(4) Chemical treatments.

(a) Liming.

(b) Fertilization.

(c) Algicide/herbicide.

(d) Alum.

(e) Oxygen.

(f) Air.

(5) River, stream, and navigation system operations.

(a) Schedule dredging, bank excavations, and other activities that generate high turbidity outside of sensitive spawning and recreation seasons.

(b) Utilize gated navigation dams to promote efficient gas exchange processes for aeration and/or stripping of volatile organic compounds.

(c) Control gated bendway pools for fish, wildlife, and water quality purposes.

(d) Encourage creative use of dredge disposal areas.

(6) Sediment control.

(a) Turbidity control.

(b) Silt curtain.

(c) Silt barriers to control nutrient leachates.

(7) Hydropower operations.

(a) Moderation of exaggerated flow increment problems, ramping, or stepping discharge rates.

(b) Spillage/discharges for recreation.

(c) Turbine venting.

(d) Modification of peaking operations to be less environmentally disruptive.

*c. Institutional opportunities.*

(1) Coordinate with state, Federal, and local agencies, local universities, recreation, conservation, and other public interest groups, industrial and municipal water users, and hydropower, agriculture, and navigation interests.

(2) Schedule meetings with these groups to exchange data and share information.

(3) Establish communication channels and emergency notification systems.

(4) Establish cooperative monitoring programs (i.e., data sharing and reporting).

(5) Prepare letters to express concerns and Federal interests in basin water quality management (these letters can be effective environmental initiatives).

(6) Provide outside distribution of division/district annual water quality reports.

(7) Use cross training and temporary assignments.

(8) Use interdisciplinary coordination (teamwork).

**A-8. (Guidance) Development and Implementation of Environmental Initiatives**

Water management guidance activities for implementing the Corps policy to meet the environmental engineering initiatives of the Chief of Engineers are categorized as evaluation, action, and coordination.

*a. Evaluation activities.*

(1) Evaluate the suitability of project water quality, including that of reservoir releases for applicable project purposes.

(2) Determine and report whether the water quality from each project is in compliance with applicable state and Federal water quality standards/criteria.

(3) Maintain an awareness of watershed activities that may constitute potential water quality problems, such as contaminants, agricultural runoff, land clearing, and mining.

*b. Action activities.*

(1) Define and report baseline water quality conditions for each project. This is normally a preproject water quality evaluation, but, for some projects, where preproject data do not exist, this is a description of the postconstruction water quality based on the earliest data available.

(2) Identify and monitor conditions and parameters important to human health and environmental integrity.

(3) Utilize, analyze, and electronically store the data.



(4) Identify and report existing and potential water quality problems, develop management plans to address problems, determine environmentally advantageous management opportunities, and identify quality and environmental trends associated with project waters.

(5) Maintain an adequate water quality monitoring and data evaluation program to achieve project objectives.

*c. Coordination activities.*

(1) Internal coordination.

(a) Work closely with the water control elements, resource managers, and planners to optimize reservoir water management for water quality where possible.

(b) Maintain coordination within the division and with individuals in each district, and encourage coordination among individuals involved in water quality within each district.

(c) Participate in Corps-sponsored training, workshops, and seminars.

(2) External coordination.

(a) Maintain close coordination with Federal, state, and local agencies responsible for watershed pollution control activities that may affect the water quality associated with Corps projects.

(b) Share data and information with all interested parties.

(c) Establish partnerships and cooperation arrangements with water and related resource users.

(d) Maintain close coordination with water users in tributary drainage basins and along downstream target reaches.

**A-9. Plans**

Comprehensive water quality plans should be developed for each project. Once established, plans should be implemented and become a part of the water control plan where they are periodically reviewed and updated.

**A-10. Summary**

This ETL has been formulated to provide engineering guidance for application of environmental engineering initiatives to promote sound management at Corps of Engineers water resource projects. Managers should apply these and other innovative techniques on a site-specific and regional basis. Sound water management decisions are the result of interdisciplinary, collaborative efforts, inclusive of the necessary technical expertise. Attainment of the Army's environmental stewardship vision demands a team approach, a willingness to change, a can-do spirit, and support at all levels of the organization. To this end the Corps is committed. Additional or specific guidance on issues arising from the material presented in this ETL is available from the Corps of Engineers' Committee on Water Quality (CECW-EH-W at (202) 761-8512).